

**NATURAL RESOURCES CONSERVATION SERVICE****CONSERVATION PRACTICE STANDARD****GRADE STABILIZATION STRUCTURE**

(no.)  
Code 410

**DEFINITION**

A structure used to control the grade and head cutting in natural or artificial channels.

**PURPOSE**

To stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.

**CONDITIONS WHERE PRACTICE APPLIES**

In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. Special attention shall be given to maintaining or improving habitat for fish and wildlife where applicable.

**Scope**

This standard applies to all types of grade stabilization structures, including a combination of earth embankments and mechanical spillways and full-flow or detention-type structures. This standard also applies to channel side-inlet structures installed to lower the water from a field elevation, a surface drain, or a waterway to a deeper outlet channel. It does not apply to structures designed to control the rate of flow or to regulate the water level such as the practice **Structure for Water Control** (Code 587).

**CRITERIA**

The structure must be designed for stability after installation. The crest of the inlet must be set at an elevation that stabilizes upstream head cutting.

**Embankment Dams**

Class (a) dams that have a product of storage times the effective height of the dam of 3,000 or more, those more than 35 feet in effective height, and all class (b) and class (c) dams shall meet or exceed the requirements specified in Technical Release No. 60 (TR-60).

Class (a) dams that have a product of storage times the effective height of the dam of less than 3,000 and an effective height of 35 feet or less shall meet or exceed the requirements specified for **Pond** (Code 378).

The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.

**Pond Size Dams**

If mechanical spillways are required, the minimum capacity of the principal spillway shall be that required to pass the peak flow expected from a 24-hour duration design storm of the frequency shown in Table 1, less any reduction because of detention storage.

If the effective height of the dam is less than 20 feet and the emergency spillway has a stable grade throughout its length with no overfalls and has good vegetation to its reentry into the downstream channel, the principal spillway capacity may be reduced but can be no less than 80 percent of the 2-year frequency, 24-hour duration storm.

If criteria values exceed those shown in Table 1 or the storage capacity is more than 50 acre feet, the 10-year frequency, 24-hour duration storm must be used as the minimum design storm.

Grade stabilization structures with settled fill height of less than 15 feet and 10-year frequency, 24-hour duration storm runoff less than 10 acre-feet, shall be designed to control the 10-year frequency storm without overtopping. The mechanical spillway, regardless of size, may be considered in design and an emergency spillway is not required if the combination of storage and mechanical spillway discharge will handle the design storm. The embankment can be designed to meet the requirements for the practice **Water and Sediment Control Basin** (Code 638) rather than the requirements for **Pond** (Code 378).

### Full Flow, Open Structures

Drop, chute, and box inlet drop spillways shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices, the National Engineering Handbook, and other applicable SCS publications and reports. The minimum capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction because of detention storage. If site conditions exceed those shown in Table 2, the minimum design 24-hour duration storm is 25 year frequency for the principal spillway and 100 year frequency for total capacity. Structures must not create unstable conditions upstream or

downstream. Provisions must be made to insure reentry of bypassed storm flows.

Toe wall drop structures can be used if the vertical drop is 4 feet or less, flows are intermittent, downstream grades are stable, and tail water is at or near the crest of the weir at design flow.

The ratio of the capacity of drop boxes to road culverts shall be as required by the responsible road authority or as specified in Table 2 or 3, as applicable, less any reduction because of detention storage, whichever is greater. The drop box capacity (attached to a new or existing culvert) must equal or exceed the culvert capacity at design flow.

### Island-type Structures

If the mechanical spillway is designed as an island-type structure, its minimum capacity shall equal the capacity of the downstream channel. For channels with very small drainage areas, the mechanical spillway should carry at least the 2-year frequency, 24-hour duration storm or the design drainage curve runoff. The minimum emergency spillway capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2 for total capacity without overtopping the headwall extensions of the mechanical spillway. Provisions must be made for safe reentry of bypassed flow as necessary.

### Side-inlet Drainage Structures

The design criteria for minimum capacity of open-weir or pipe structures used to lower surface water from field elevations or lateral channels into deeper open channel are shown in Table 3. The minimum principal spillway capacity shall equal the design drainage curve runoff for all conditions. If site condition values exceed those shown in Table 3, the 50-year frequency storm shall be used for minimum design of total capacity.

### **Landscape Resources**

In highly visible public areas and those associated with recreation, careful consideration should be given to landscape resources. Landforms, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat. Exposed concrete surfaces may be formed to add texture or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.

### **General Criteria**

Earth embankment and emergency spillways of structures for which criteria are not provided under the standard for ponds (378) or in TR-60 must be stable for all anticipated conditions. If earth spillways are used, they must be designed to handle the total capacity flow indicated in Tables 2 or 3 without overtopping the dam. The foundation preparation, compaction, top width, and side slopes must ensure a stable dam for anticipated flow conditions. Discharge from the structure shall be sufficient that no crop damage results from flow detention.

Necessary sediment storage capacity must equal the expected life of the structure, unless a provision is made for periodic cleanout.

Earth embankment pond structures are potentially hazardous and precautions must be taken to prevent serious injury or loss of life. Protective guardrails, warning signs, fences, or lifesaving equipment shall be added as needed.

If the area is used for livestock, the structure, earthfill, vegetated spillways, and other areas should be fenced as necessary

to protect the structure. Near urban areas, fencing may be necessary to control access and exclude traffic that may damage the structure or to prevent serious injury or death to trespassers.

### **Protection**

Exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded or sodded as necessary to prevent erosion. If climatic conditions preclude the use of vegetation, nonvegetative coverings such as gravel or other mulches may be used.

## **PLANNING CONSIDERATIONS FOR WATER QUANTITY AND QUALITY**

### **Water Quantity**

1. Effects on volumes and rates of runoff, evaporation, deep percolation and ground water recharge.
2. Effects of the structure on soil water and resulting changes in plant growth and transpiration.

### **Water Quality**

1. Ability of structure to trap sediment and sediment-attached substances carried by runoff.
2. Effect of structure on the susceptibility of downstream stream banks and stream beds to erosion.
3. Effects of proposed structure on the movement of dissolved substances to ground water.
4. Effects on the visual quality of downstream water resources.

## **CONSTRUCTION PLANS**

Plans for installation of grade stabilization structures shall be in keeping with this standard and shall describe the

requirements for application for the practice to achieve its intended purpose.

Construction plans for earth embankments should include a plan layout of the embankment and reservoir, profile of the embankment, cross section of the emergency spillway, dimensions of the principal spillway or outlet pipe, and details of the principal spillway riser.

Plans for drop and chute spillways shall show sufficient structural details to insure that the structure can be constructed as designed.

All material requirements shall be shown on the construction plans.

Construction of grade stabilization structures within the scope of Technical Release 60 (TR-60) shall be in accord with the Guide Specifications contained in National Engineering Handbook, Section 20.

**Table 1 - Design Criteria for establishing minimum capacity of the principal spillway for dams with storage capacity of less than 50 acre-feet.**

Maximum drainage area for indicated rainfall <sup>1/</sup> (5 + in.)	Effective height of dam (ft.)	Frequency of minimum design, 24-hour duration storm (yr.)
50	35 or less	2
100	20 or less	2
100	20-35	5
200	20 or less	5

<sup>1/</sup> In a 5-year frequency, 24-hour duration storm.

**Table 2 - Design Criteria for establishing minimum capacity of flow open structures.**

		Frequency of minimum design, 24-hour duration storm	
Maximum Drainage Area for Indicated Rainfall <sup>1/</sup> (5 + in.)	Vertical Drop (ft.)	Principal Spillway Capacity (yr.)	Total Capacity (yr.)
250	5 or less	5	10
500	10 or less	10	25

<sup>1/</sup> In a 5-year frequency, 24-hour duration storm.

**Table 3 - Design Criteria for establishing minimum capacity of side-inlet, open-weir, or pipe-drop drainage structure.**

		Frequency of minimum design, 24-hour duration storm	
Maximum Drainage Area for Indicated Rainfall <sup>1/</sup> (5 + in.)	Vertical Drop (ft.)	Receiving Channel Depth (yr.)	Total Capacity (yr.)
250	0-5	0-10	--
250	5-10	10-20	10
500	0-10	0-20	25

<sup>1/</sup> In a 5-year frequency, 24-hour duration storm.